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Hansen

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[54] **SUPPORT ARM**

[76] Inventor: **Henning Hansen**, 1470 Highbush Trail, Pickering, Canada, L1V 1N5

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[51] **Int. Cl.**[6] **B25J 11/00**; B25J 17/00

[52] **U.S. Cl.** **74/490.02**; 74/490.05; 248/276.1; 248/278.1; 285/118; 285/907; 414/918; 901/28

[58] **Field of Search** 74/490.02, 490.05; 248/276.1, 278.1, 282.1, 284.1; 285/118, 163, 181, 137.1, 136, 184, 907; 414/918; 901/28, 29

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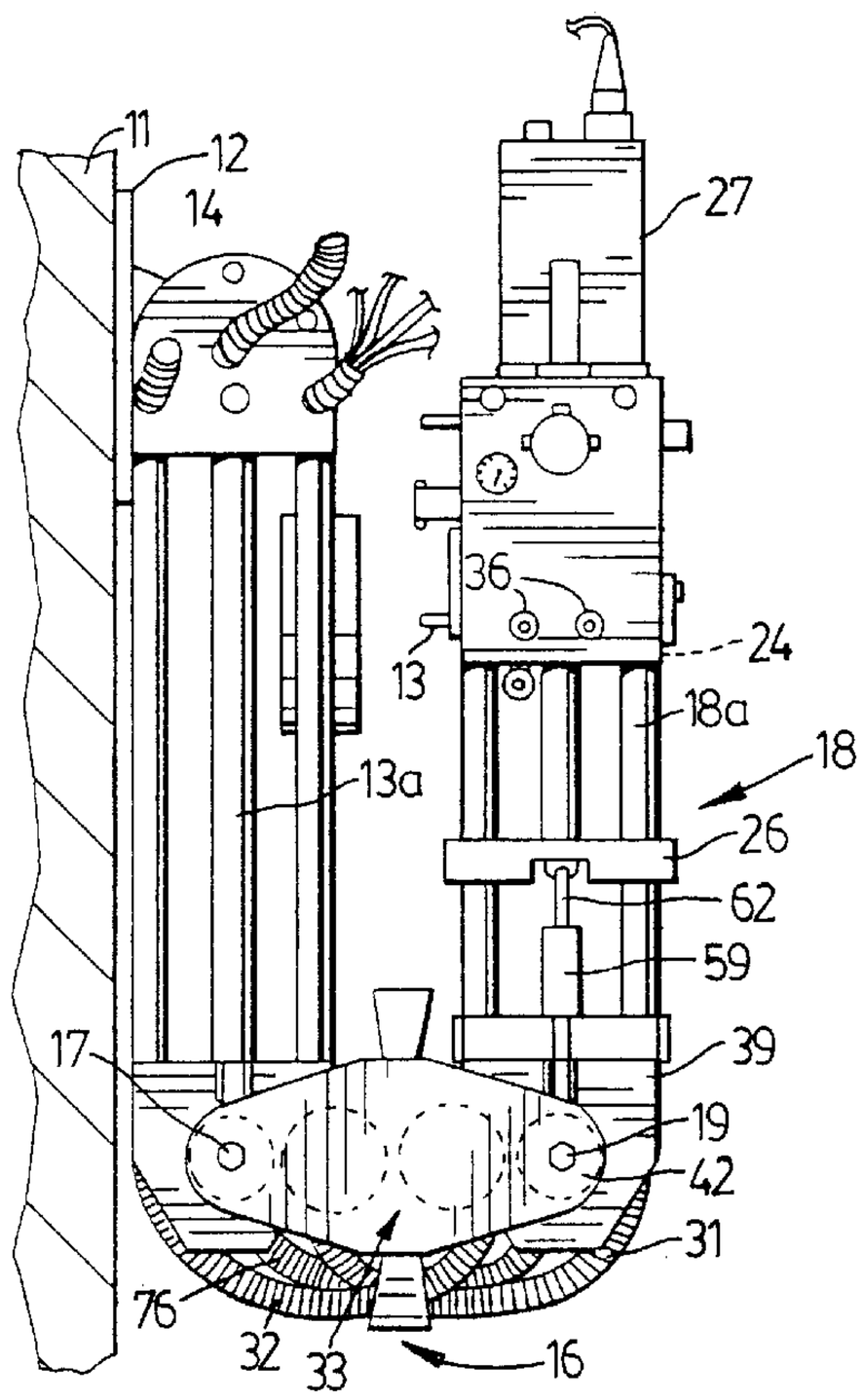
Primary Examiner—Allan D. Herrmann
Attorney, Agent, or Firm—Ridout & Maybee

[57] **ABSTRACT**

A support arm has stationary support structure, a boom, a knuckle and an auxiliary jib section. The boom connects at one end to the support structure and at an opposite end to one end of the knuckle, and an opposite end of the knuckle connects to one end of the auxiliary jib section. Each connection is a pivotal connection for pivoting about vertical pivot axes. An opposite end of the auxiliary jib section connects to a main jib section through a pivotal connection for pivoting about a horizontal axis. First and second flexible tubes connect across the knuckle and the auxiliary jib section between the boom and the main jib section. The flexible tubes extend from points on the main jib section in parallel horizontally spaced relationship and pass slippingly and in parallel longitudinally through parallel horizontally spaced guide sleeves that are connected on the auxiliary jib section. In the region of the knuckle the flexible tubes converge and cross over one another in a loosely curved configuration toward horizontally spaced points on the opposite end of the boom. A drive adjusts the elevation of the main jib section by pivoting it about the horizontal pivot axis, between an upper position parallel to the boom and a lower position inclined downwardly thereto. This arrangement allows vertical rise and fall of the main jib section and pivoting of the jib horizontally relative to the boom.

7 Claims, 4 Drawing Sheets



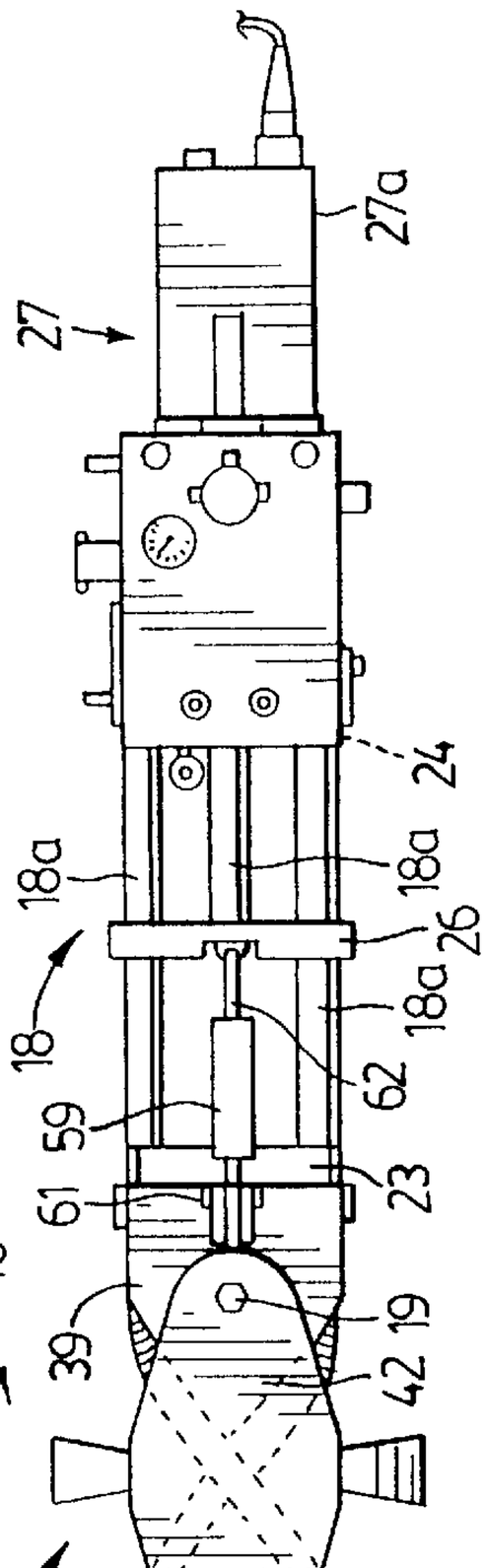

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FIG. 1

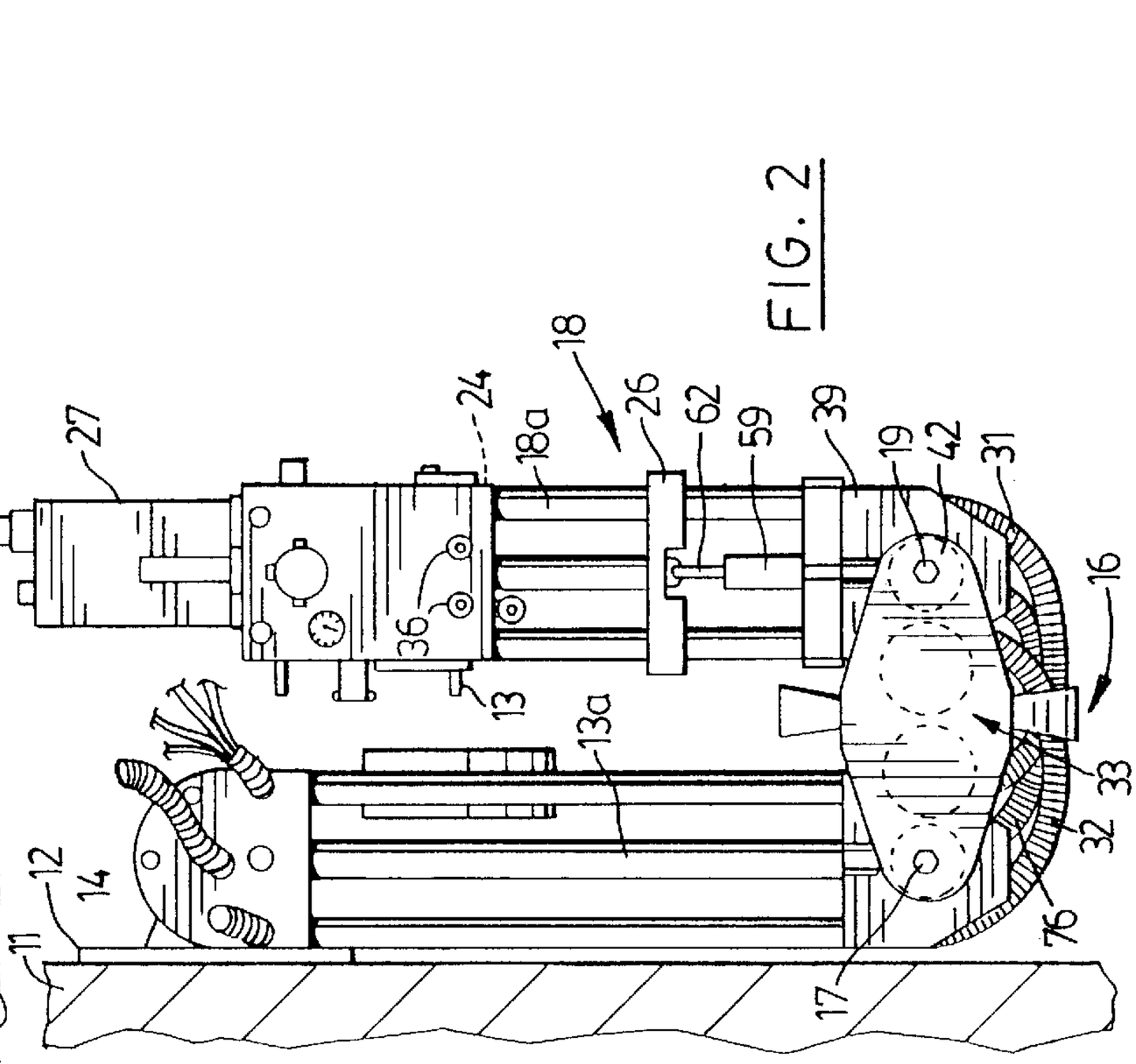
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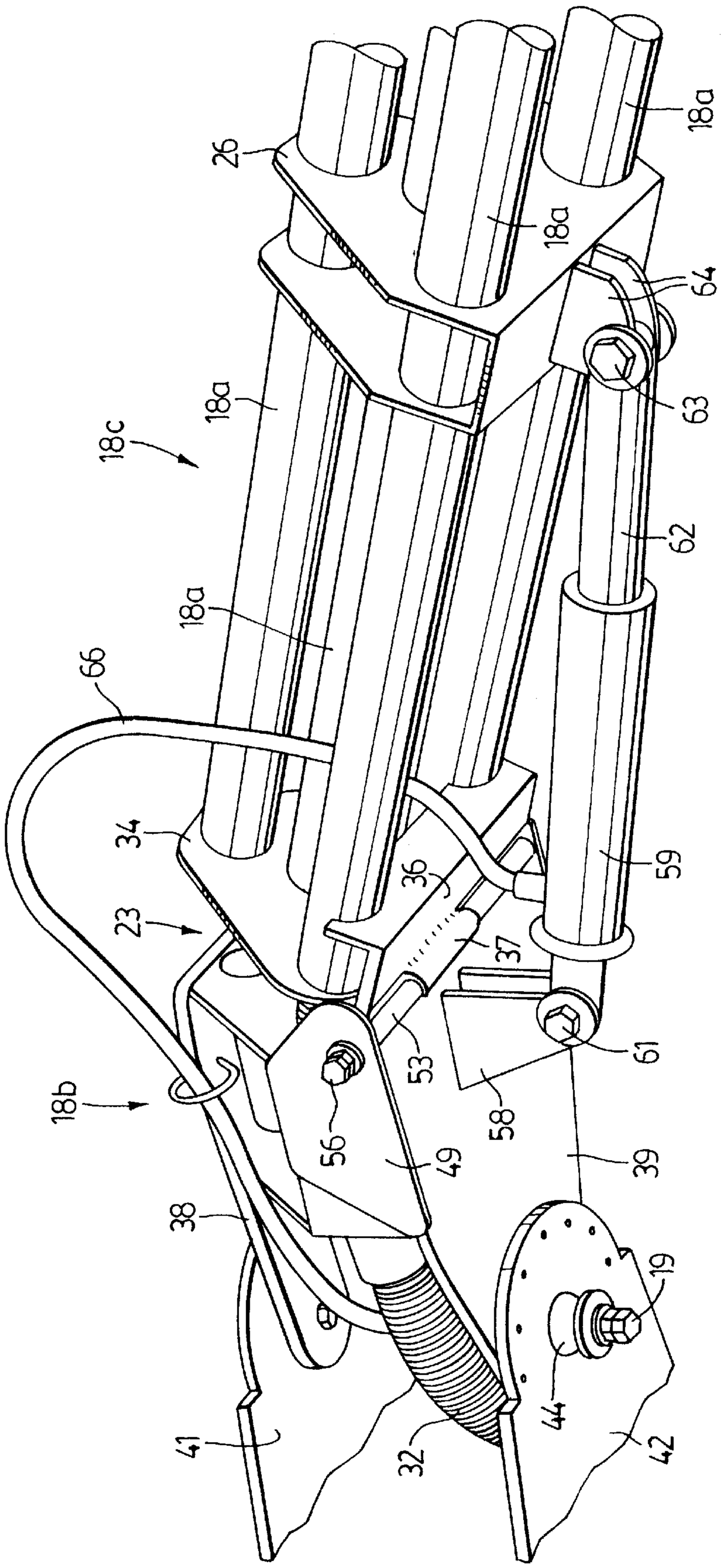
FIG. 2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18a
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18c
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18a
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FIG. 3

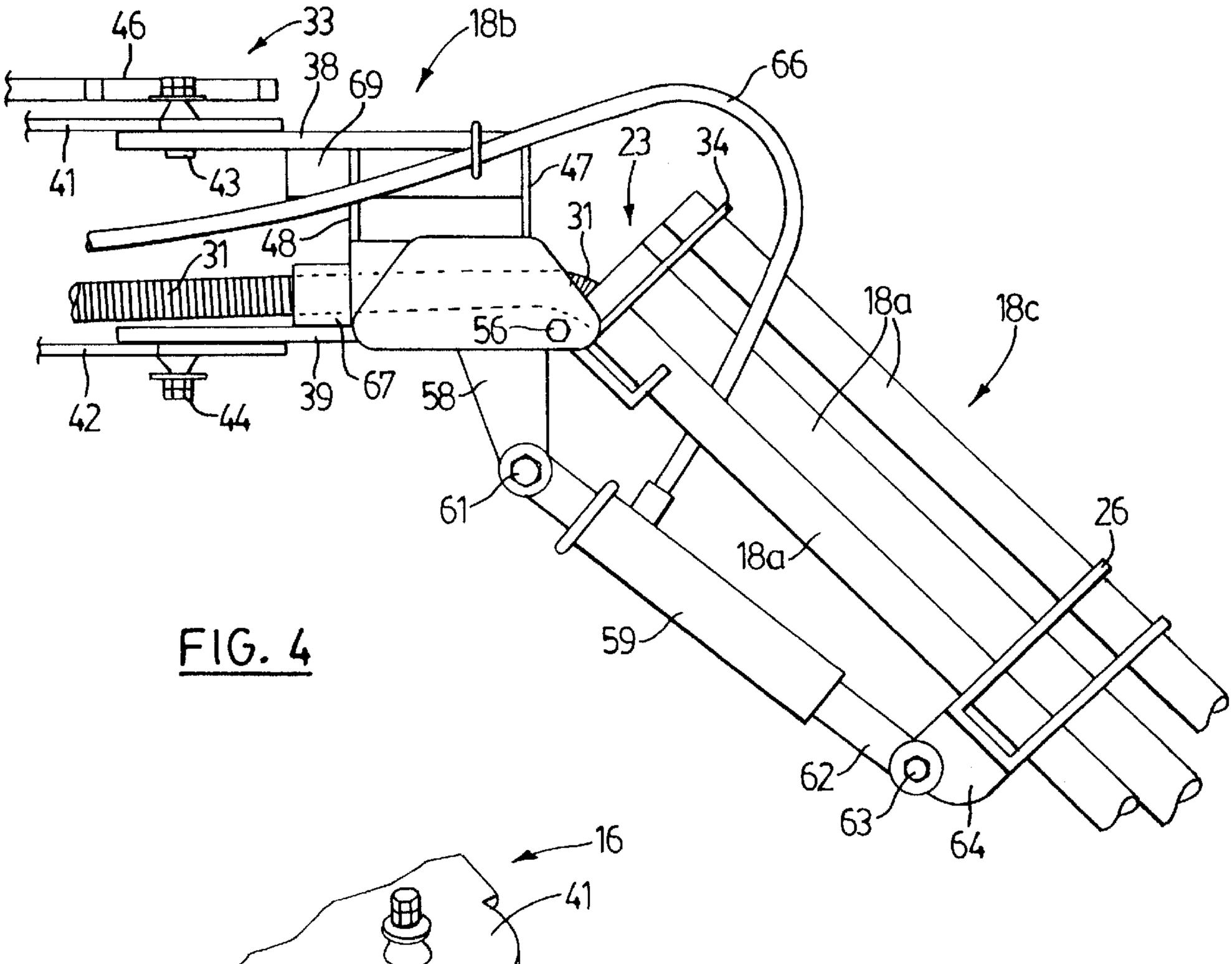
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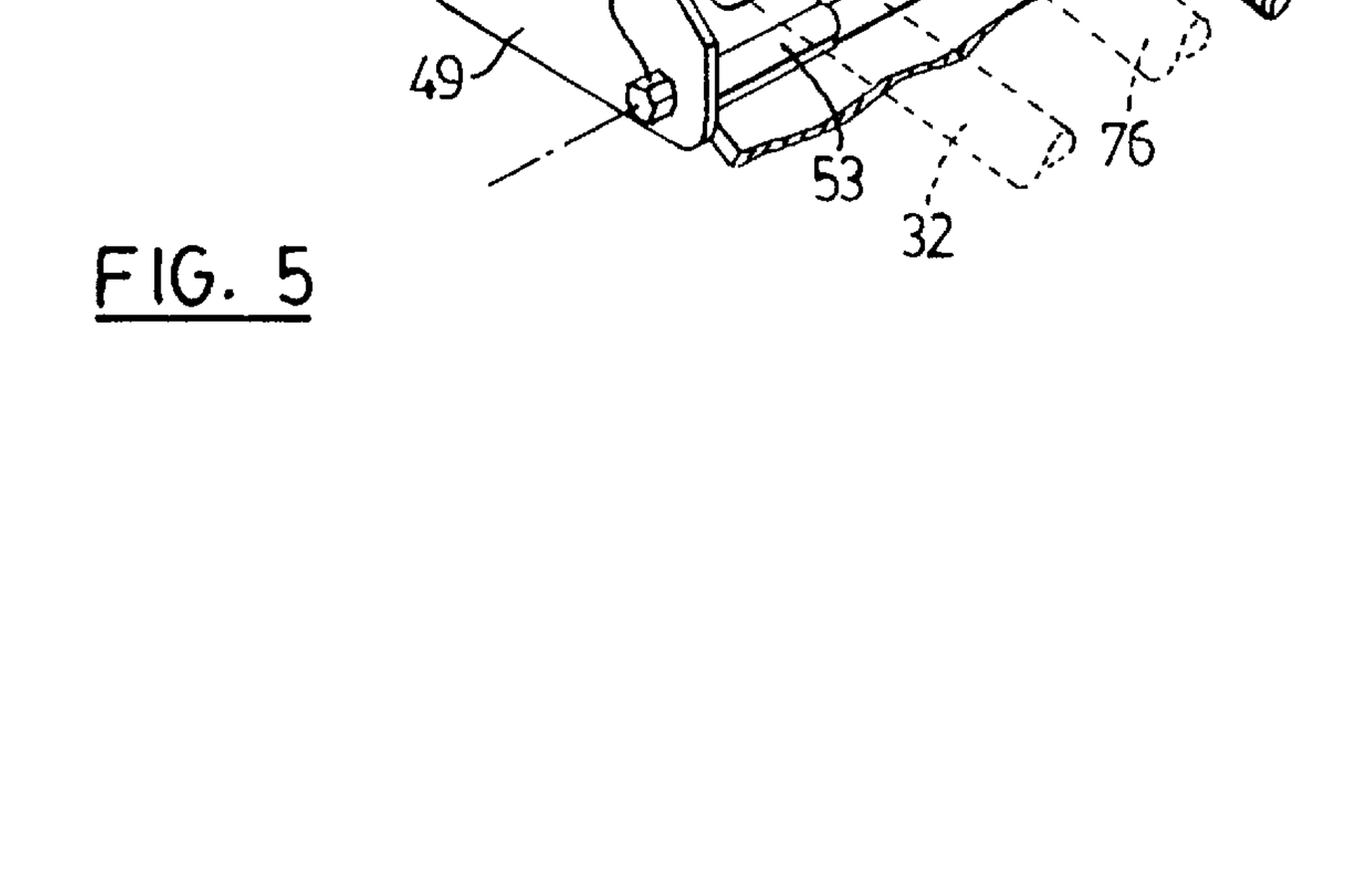
FIG. 4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18b
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FIG. 5

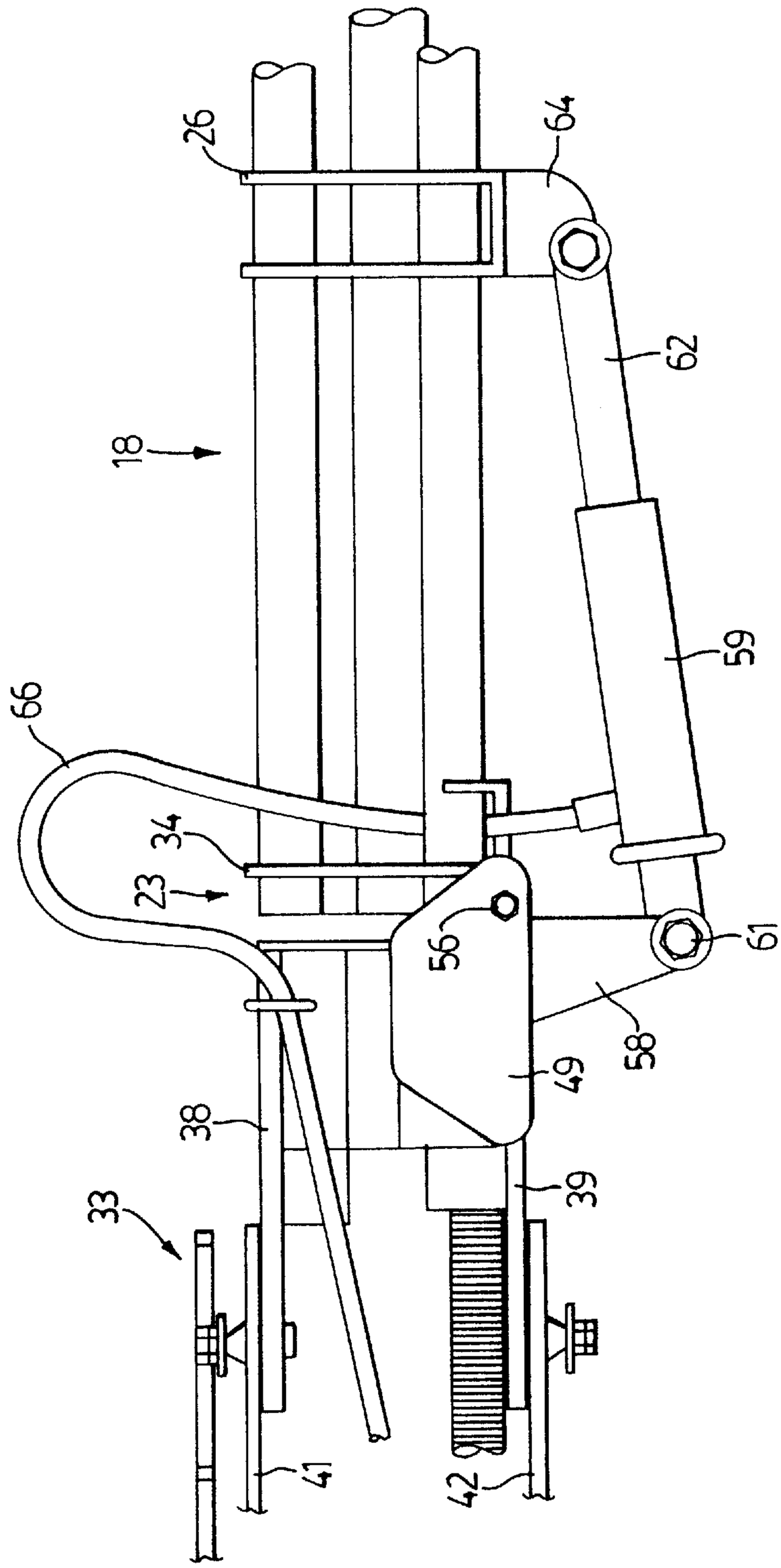

FIG. 6

SUPPORT ARM

BACKGROUND OF THE INVENTION

The present invention relates to an improved support arm. More especially, the improved support arm of the present invention includes a section that is pivotable about a horizontal axis between raised and lowered positions. The arm of the invention is therefore well adapted to be supported at considerably greater elevation than known support arms while still allowing access to be had to a load carried at the end of the arm by pivoting the section above-mentioned to a lowered position.

Usually, however, it is desired to provide flexible tubes running longitudinally through articulated sections of the support arm, for example for the purpose of providing fluid pressure or vacuum services at the load end of the arm. When the support arm is provided with a section that can be raised and lowered about a pivotal axis, the flexible tubes tend to be exposed to wear and damage as a result of binding, catching or rubbing wear on the rigid articulated elements of the support arm.

SUMMARY OF THE INVENTION

In the present invention there is provided a support arm comprising stationary support structure, a boom, a knuckle and an auxiliary jib section, said boom connected at one end to the support structure and at an opposite end to one end of the knuckle, and an opposite end of the knuckle to one end of the auxiliary jib section each through pivotal connections for pivoting about respective vertical pivot axes, an opposite end of the auxiliary jib section being connected to a main jib section through a pivotal connection for pivoting about a horizontal axis, first and second flexible tubes connecting across the knuckle and the auxiliary jib section between the boom and the main jib section, and wherein the flexible tubes extend from points on the main jib section in parallel horizontally spaced relationship and passing slippingly and in parallel longitudinally through parallel horizontally spaced guide sleeves connected on the auxiliary jib section and in the region of the knuckle converging and crossing one over the other in loosely curved configuration toward horizontally spaced points on said opposite end of the boom, and means for adjusting the elevation of the main jib section by pivoting it about said horizontal pivot axis, between an upper position parallel to the boom and a lower position inclined downwardly thereto.

With this arrangement, the portions of the flexible tube extending through the knuckle and through at least a major portion of the guide sleeves remain at a substantially constant horizontal level regardless of the elevation of the main jib section and regardless of the angle of the auxiliary jib section to the knuckle. Extension or retraction of the flexible tubes concomitant on lowering or raising of the main jib section, respectively, is accommodated by some straightening out and tautening of the loosely curved portions of the flexible tubes on lowering of the main jib section and re-adoption of the loosely curved configuration on raising of the main jib section, respectively.

In a preferred form, the above mentioned horizontal pivot axis is positioned so that it is adjacent the points on the main jib section from which the flexible tubes extend, at least at the upper position of the main jib section. With this arrangement, the portions of the flexible tubes adjacent the main jib section tend to be raised upwardly slightly relative to the guide sleeves as the main jib section is lowered, so that free slipping of the flexible tubes through the guide sleeves is facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is more fully described with reference to the accompanying drawings, by way of example only.

FIG. **1** is a bottom plan view of an improved support arm in an out stretched configuration.

FIG. **2** is a bottom plan view of the arm in folded configuration.

FIG. **3** is a partial perspective view from underneath of a hinge portion of the arm.

FIG. **4** is a side view of the hinge portion.

FIG. **5** is a partial perspective view from above of the hinge portion.

FIG. **6** is a side view corresponding to FIG. **4**, showing the arm in elevated condition.

DESCRIPTION OF THE EMBODIMENTS

Referring to the drawings, wherein like reference numerals indicate like parts, FIG. **1** shows an arm **10** mounted on a vertical support surface such as a wall **11**. A mounting bracket **12** is secured to the wall. The arm **10** comprises a boom **13** pivotally connected to the bracket **12** for example at **14** to pivot about a vertical pivot axis, a knuckle **16** pivoted to the boom **13** at **17** to pivot about a vertical axis and a jib **18** pivoted to the knuckle **16** at **19** to pivot about a vertical pivot axis.

The structure and operation of the boom, jib and knuckle is described in more detail in applicant's U.S. Pat. Nos. 5,025,126 and 5,086,206, the disclosures of each of which are incorporated herein by reference.

Briefly, each of the boom **13** and jib **18** consist of sets of rigid usually steel tubes disposed longitudinally parallel with one another, such tubes being indicated at **13***a* for the boom **13** and **18***a* for the jib **18** in the accompanying drawings. The tubes are held in spaced relationship to one another to form a rigid open framework by being secured, for example by welding, to rigid end members **21**, **22**, **23** and **24** including generally plate form portions extending at right angles to the tubes and having circular openings through which the tubes pass.

In the preferred form, the jib **18** comprises an intermediate apertured spacer member **26** again secured to the external surfaces of the tubes **18***a*, for example by welding.

The boom and jib of the support arm as shown preferably each comprise a set of four of the parallel rigid tubes. As best seen in FIG. **3**, three of the tubes have their axes substantially at the corners of an equilateral triangle and the fourth tube has its axis substantially at the center of the equilateral triangle.

The tube **13***a* and **18***a* provide at least partially encased access channels for conveying fluids and the like between the support end of the support arm, that is to say the rearward end of the boom **13** and the load end of the support arm, that is to say the free end of the jib **18**. For example, as described in more detail in applicant's above mentioned U.S. patents, the load end **27** of the arm may carry welding service equipment **27***a*. The tubes **13***a* and **18***a* are used as part of a fluid flow path. For example, the tubes may be used as a conduit along which a vacuum, dust extraction and/or fume extraction services are provided to the load end **27** of the arm. For this purpose, the two lower tubes of the sets of tubes **13***a* and **18***a* are preferably employed. A flexible tube **28** at the support end may connect to a vacuum apparatus (not shown) such as a centrifugal cyclone precipitator. The

other end of the flexible tube **28** connects through a sealing end cap to the adjacent or support end of one of the lower tubes **13***a*. Similarly, a flexible conduit **29** may connect to a fume extraction device, such as a blower and filter assembly (not shown). The other end of the tube **29** connects sealingly through an end cap to the adjacent end of the other of the two lower tubes **13***a*. The opposite ends of the tubes **13***a* adjacent the knuckle **16** connect sealingly through end caps to a pair of flexible hoses **31** and **32**. As described in applicant's above mentioned U.S. patents, and as shown in FIGS. **1, 2** and **5**, these hoses **31** and **32** cross over one another within the knuckle **16** and then connect sealingly through end caps with the lower pair of tubes **18***a*. Adjacent the load end **27**, the tubes **18***a* communicate to the vacuum and fume extraction service portions respectively of the welding service device **27***a* or the like. As discussed in applicant's above mentioned U.S. patents, by having the hoses **31** and **32** cross over in a loosely curved configuration within the knuckle **16**, when the jib **18** is pivoted in a horizontal plane relative to the boom **13**, for example as in the folded configuration shown in FIG. **2**, the curved portions of the flexible tubes **31** and **32** arch laterally to accommodate such pivoting without subjecting the tubes to undue deformations or stresses.

In the preferred form, the boom **13** and jib **18** are connected through an equiangular drive, for example a gear train **33** as indicated in FIGS. **2, 4** and **6** described in more detail in applicant's U.S. Pat. No. 5,086,206, that maintain the jib and boom each at the same angle to the longitudinal axis of the knuckle **16**, that is to say the axis extending between the pivot point **17** and **19**, so that uncontrolled movements of the knuckle relative to the boom or jib tending to pinch or deform the flexible tubes **31** and **32** are avoided.

In the present invention, in order to provide a vertical rise and fall function to the support arm, the jib **18** is formed in two sections, namely auxiliary and main sections **18***b* and **18***c*, respectively. The main jib section **18***c* comprises the rigid horizontal tubes **18***a* described above, the tubes **18***a* at the end adjacent the auxiliary section **18***b* passing through and being secured in a rigid plate-like end fitting **34** as seen in FIGS. **3, 4** and **6** and forming part of the rigid end member **23**. A lower portion of the end member **23** comprises a lower transversely extending plate **36** to the lower side of which a laterally extending cylindrical hinge sleeve **37** is secured.

The auxiliary jib section **18***b* comprises vertically spaced horizontally extending upper and lower plates **38** and **39** pivotally connected to upper and lower plate portions **41** and **42**, respectively of the knuckle **16** through pivot axles **43** and **44**. The upper plate **38** may be keyed to the lower end of the axle **43** and the upper end of the axle **43** keyed to a spur gear **46** forming part of the gear train **33** above referred to.

The horizontal plates **38** and **39** are interconnected by a pair of generally triangular vertical spaced transverse plates **47** and **48**. The plates **47** and **48** are further interconnected by longitudinally extending vertical cheek portions **49** and **51** between which extends a transversely extending pin forming a hinge pin for a hinge connection between the auxiliary and main sections **18***b* and **18***c*. The pin passes through the sleeve **37** attached to the lower plate portion **36**, and through similar cylindrical sleeves **53** and **54** secured to a lower front edge of the forward plate **47**. The ends of the pin are located, such as by a head, a nut, a clip or other locating device **56** on the outer flank of the cheek portions **49** and **51**. This hinge arrangement allows for hinging of the main jib portion **18***c* about a horizontal axis **57** indicated in FIG. **5**.

A drive is connected between the auxiliary jib portion **18***b* and the main jib portion **18***c* for raising and lowering the main jib portion **18***c*. Various forms of drive may, of course, be employed. In the example illustrated, a fluid operated piston and cylinder arrangement is employed, for example a hydraulic jack. A yoke portion **58** extends downwardly from the lower plate **39** of the auxiliary jib section **18***b* and a cylinder **59** of the hydraulic jack is connected pivotally to a lower portion of the yoke **58** at **61**. The piston rod **62** of the jack is connected pivotally at **63** to a paid of spaced cheek portions **64** extending downwardly from the intermediate rigid spacer member **26**.

A pressurized fluid supply line **66** connects to the cylinder **59** for actuation of the jack in the conventional manner. In the stored or horizontal position shown in FIGS. **1, 2** and **6**, the arm may extend at a considerable elevation above the ground surface at which it would be inaccessible to an operator of ordinary height. A control device for controlling a pressure source and valving in conventional manner for actuating the jack is therefore preferably provided at ground level, for example is suspended from a control cable for ease of access by the operator.

In use, when the operator wishes to have access to the welding supply service equipment or other load **27***a*, the control is actuated to release fluid from the cylinder **59** along the line **66** so that the main jib section **18***c* pivots downwardly about the axis **57** to the lowered position seen in FIGS. **3** and **4**. In this position, the load **27***a* or load end **27** of the support arm **10** is at a height at which it can be readily grasped by the operator. The arm is then readily manually pivotable about the vertical pivot axes **14, 17** and **19**, so that the load **27***a* may then be positioned at any desired point within the semi-circular area described by rotation of the support arm **10** about the vertical pivot axis **14**. The control device can be operated to actuate the jack to retract the piston **62** relative to the cylinder **59** and rock the jib section **18***c* upwardly to the FIG. **6** position once access is no longer desired to be had to the load end **27**, in order to restore the jib to an elevated or stored position. The jack may include conventional limit switches to limit travel of the piston **62** and rocking motion of the jib section **18***c* between certain limits to avoid stressing the arm structures.

The auxiliary jib section **18***b* is provided with a series of cylindrical guide sleeves **67, 68, 69** and **71** that, in the elevated or horizontal position of the support arm as seen in FIG. **6** are aligned with the tubes **18***a* of the main jib section **18***c*. The sleeves **67** to **71** pass through apertures in the vertical plates **47** and **48**, and are secured thereto by welding. Preferably, the sleeves **67** to **71** extend rearwardly to adjacent the knuckle **16**. As seen in FIG. **5**, the flexible hoses **31** and **32** extend through the two lower most guide sleeves **67** and **71**. In FIG. **5**, one flexible hose **32** is shown in broken lines for improved clarify of illustration. The internal diameter of the guide sleeves **67** to **71** is substantially larger than the diameter of the flexible hoses such as hoses **31** and **32** which pass through the sleeves. For example, the sleeves may be 10 to 50% greater in diameter than the flexible hoses, based on the diameter of the flexible hoses. More preferably, the sleeves are 15 to 40% greater in diameter. As a result, the flexible hoses tend to slip freely longitudinally through the guide sleeves, as indicated by the arrow **72** in FIG. **5**. It may be noted that the flexible tubes **31** and **32** extend from the end caps through which they connect to the lower pair of rigid tubes **18***a* rearwardly toward the guide tubes **69** and **71** in parallel horizontally spaced relationship and continue in parallel through the tubes **67** and **71**. Rearwardly toward the knuckle **16** as seen in FIGS. **1** and **5**, the tubes **31** and **32** converge toward one another and cross over within the knuckle **16**, in order to accommodate pivotal movement of

the jib and boom relative to one another as discussed above. In use, when the main jib section **18***c* drops downwardly relative to the auxiliary jib section **18***b* as seen in FIG. **4**, the tubes **31** and **32** extend and slip outwardly through the guide sleeves **67** and **71**, and this extension is accommodated by the somewhat loosely curved portions of the tubes **31** and **32** within the knuckle **16**, as seen in FIG. **1**, straightening out somewhat and elongating to some extent. The tubes have a certain amount of elastic resiliency, and therefore tend to elongate under longitudinal tension. It will be appreciated that the crossed over configuration of the tubes **31** and **32** within the knuckle **16** is generally preserved on lowering of the jib section **18***c* to the position shown in FIG. **4**, regardless of the angle of the jib **18** relative to the boom **13**, since the guide tubes **67** and **71** maintain the flexible tubes **31** and **32** in the desired configuration during the lowering of the jib section **18***c*.

In the preferred form, as seen in FIGS. **4** and **6**, the pivot axis **57**, at least in the upper or elevated position of the jib section **18***c* shown in FIG. **6** has the guide sleeve and the tubes **18***a* disposed upwardly above it. Preferably, the pivot axis **57** is vertically adjacent the points at the rear of the tubes **18***a* from which the hoses **31** and **32** extend. The flexible tubes **31** and **32** have some degree of stiffness and, as the jib **18** drops downwardly to the position of FIG. **4**, the portions of the tubes vertically adjacent the pivot axis, and adjacent the rearward ends of the tubes **18***a*, which tend to act as stiff rearward extensions of the tubes **18***a*, pivot upwardly away from the pivot axis **56**, and therefore the lower sides of the tubes **31** and **32** tends to lift upwardly from the lower inner surface of the guide sleeves **67** and **71**, as seen in FIG. **4**, so that free slipping of the flexible tubes **31** and **32** through the guide sleeve **67** and **71** is facilitated.

As indicated in FIG. **5**, the support arm may include a further flexible and resiliently elastic conduit **76** shown in broken lines extending from the support end of the arm **10** to the load end **27**. In the preferred form, this flexible conduit **76** is anchored adjacent the support end of the arm **10** adjacent the support surface **11**, and extends continuously through the central tubes **13***a* and **18***a* (at the center of the equilateral triangular formation) which are made of somewhat larger diameter, through the knuckle **16** and the central guide sleeve **68** and is anchored at the other end in the load **27***a*. On downward inclination of the auxiliary jib portion **18***c*, to the position shown in FIG. **4**, the tube **76** slips longitudinally forwardly through the guide tube **68**, the tube **76** elongating along its entire length as a result of the increase in tension in the tube on downward pivoting of the jib section **18***c* to the FIG. **4** position.

Similarly, the support arm may include a fourth flexible and elastic tube connecting between the support or rear end of the arm **10** and the load end and passing through the upper most of the tubes **13***a* and **18***a* and through the guides sleeve **69**.

I claim:

1. A support arm comprising stationary support structure, a boom, a knuckle and an auxiliary jib section, said boom connected at one end to the support structure and at an opposite end to one end of the knuckle, and an opposite end of the knuckle to one end of the auxiliary jib section each through pivotal connections for pivoting about respective vertical pivot axes, an opposite end of the auxiliary jib section being connected to a main jib section through a pivotal connection for pivoting about a horizontal axis, first and second flexible tubes connecting across the knuckle and the auxiliary jib section between the boom and the main jib section, and wherein the flexible tubes extend from points on the main jib section in parallel horizontally spaced relationship and passing slippingly and in parallel longitudinally through parallel horizontally spaced guide sleeves connected on the auxiliary jib section and in the region of the knuckle converging and crossing one over the other in loosely curved configuration toward horizontally spaced points on said opposite end of the boom, and means for adjusting the elevation of the main jib section by pivoting it about said horizontal pivot axis, between an upper position parallel to the boom and a lower position inclined downwardly thereto.

2. An arm a s claimed in claim **1** wherein said flexible tubes are each fixed at one end to said opposite end of the boom and at the other end to the main jib section.

3. An arm as claimed in claim **1** wherein said horizontal pivot axis is below and adjacent the points on the main jib section from which the flexible tubes extend in the upper position of the main jib section.

4. An arm as claimed in claim **1** wherein the means for adjusting comprise a fluid operated piston cylinder connected between the auxiliary and main jib sections.

5. An arm as claim **1** wherein said boom and main jib section comprise parallel rigid tubes that are in sealed fluid communication with said flexible tubes.

6. An arm as claimed in claim **1** wherein said guide sleeves have an internal diameter substantially larger than the outside diameter of the flexible tubes.

7. An arm as claimed in claim **1** including an equiangular drive between the auxiliary jib section and boom maintaining each at the same angle to the longitudinal axis of the knuckle.

* * * * *